Low-Level Laser Therapy Improves Performance and Reduces Fatigue in Competitive Cyclists.

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Evidence supports that low-level laser therapy (LLLT) minimizes fatigue effects on muscle performance. However, the ideal LLLT dosage to improve athletes' performance during sports activities, such as cycling, is still unclear. Therefore, the goal of this study was to investigate the effects of different LLLT dosages on cyclists' performance in time-to-exhaustion tests. In addition, we looked at the effects of LLLT on the frequency content of the EMG signals to assess fatigue mechanisms. Twenty male competitive cyclists participated in a crossover, randomized, double-blind and placebo-controlled trial. They performed an incremental cycling test to exhaustion (on day 1) followed by four time to exhaustion tests (on days 2 to 5) at their individual maximal power output (POMAX). Before each time-to-exhaustion test, different dosages of LLLT (135, 270 and 405 J/thigh, respectively) or placebo were applied at the quadriceps muscle bilaterally. Power output and muscle activation from both lower limbs were recorded throughout the tests. Increased performance in time-to-exhaustion tests was observed with the LLLT-135J (~22 s; $p<0.01$), LLLT-270J (~13 s; $p=0.03$) and LLLT-405J (~13 s; $p=0.02$) compared to placebo (149 ±23 s). Although LLLT-270J and LLLT-405J did not show significant differences in muscle activation compared to placebo, LLLT-135J led to an increased high-frequency content compared to placebo in both limbs at the end of the exhaustion test ($p\leq0.03$). In conclusion, LLLT increased time-to-exhaustion in competitive cyclists, suggesting this intervention as a possible non-pharmacological ergogenic agent in cycling. Among the different dosages, LLLT-135J seems to promote the best effects.

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Is photobiomodulation therapy better than cryotherapy in muscle recovery after a high-intensity exercise? A randomized, double-blind, placebo-controlled clinical trial.

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This study aimed to determine the effectiveness of photobiomodulation therapy (PBMT) and cryotherapy, in isolated and combined forms, as muscle recovery techniques after a muscle fatigue-inducing protocol. Forty volunteers were randomly divided into five groups: a placebo group (PG); a PBMT group (PBMT); a cryotherapy group (CG); a cryotherapy-PBMT group (CPG); and a PBMT-cryotherapy group (PCG). All subjects attended four sessions at 24-h intervals, during which they were submitted to isometric assessment (MVC) and blood collection pre-exercise 5 min and 60 min post-exercise. The muscle fatigue induction protocol occurred after the pre-exercise collections and the remaining sessions were performed 24, 48, and 72 h later where further blood collections and isometric exersizes were performed. A single treatment with THOR LED PBMT and/or cryotherapy was applied 2 min after completing the isometric exersizes at the first session only. Comparing the results of MVCs between groups, we observed significant increases in the MVC capacity of all groups that included PBMT ($p < 0.05$) and a significant decrease in the concentrations of the biochemical markers of oxidative damage (TBARS and PC) and muscle damage (creatine kinase-CK) in the PBMT groups when compared with the PG and CG groups ($p < 0.01$). The clinical impact of these findings is clear because they demonstrate that the use of phototherapy is more effective than the use of cryotherapy for muscle recovery, additionally cryotherapy decreases PBMT efficacy.

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Effects of low-level laser therapy applied before or after plyometric exercise on muscle damage markers: randomized, double-blind, placebo-controlled trial.

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Promising effects of phototherapy on markers of exercise-induced muscle damage has been already demonstrated in constant load or isokinetic protocols. However, its effects on more functional situations, such as plyometric exercises, and when is the best moment to apply this treatment (pre- or post-exercise) remain unclear. Therefore, the purpose of this study was to investigate the effect of low-level laser therapy (LLLT) before or after plyometric exercise on quadriceps muscle damage markers. A randomized, double-blinded, placebo-controlled trial was conducted with 24 healthy men, 12 at pre-exercise treatment group and 12 at post-exercise treatment group. Placebo and LLLT (810 nm, 200 mW per diode, 6 J per diode, 240 J per leg) were randomly applied on right/left knee extensor muscles of each volunteer before/after a plyometric exercise protocol. Muscular echo intensity (ultrasonography images), soreness (visual analogue scale - VAS), and strength impairment (maximal voluntary contraction - MVC) were assessed at baseline, 24, 48, and 72 h post-exercise. Legs treated with LLLT before or after exercise presented significantly smaller increments of echo intensity (values up to 1 %) compared to placebo treatments (increased up to approximately 7 %). No significant treatment effect was found for VAS and MVC, although a trend toward better results on LLLT legs have been found for VAS (mean values up to 30 % lesser than placebo leg). In conclusion, LLLT applied before or after plyometric exercise reduces the muscle echo intensity response and possibly attenuates the muscle soreness. However, these positive results were not observed on strength impairment.

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Low-level laser therapy reduces the fatigue index in the ankle plantar flexors of healthy subjects.

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Low-level laser therapy (LLLT) has been suggested as a resource capable of increasing resistance to fatigue and enhancing muscle performance through its metabolic and photochemical effects. This study evaluated the immediate effects of the application of LLLT on neuromuscular performance of the plantar ankle flexors in healthy subjects through a fatigue-induced protocol. This is a randomized controlled clinical trial, attended by 60 young and physically active volunteers of both genders. The subjects were randomly assigned into three groups, control, placebo, and laser, and underwent a preliminary evaluation of the isokinetic performance of plantar flexors and electromyographic activity of the soleus muscle to ensure homogeneity between groups. After the application of the respective intervention protocols, participants were induced to fatigue by performing 100 isokinetic concentric contractions of ankle plantar flexors at a speed of 90 degrees /s. The dynamometric fatigue index (DFI) and median frequency were recorded during the fatigue protocol for comparison between groups. The group receiving the laser application showed significantly lower dynamometric fatigue index ($p = 0.036$) when compared to control and placebo groups. In relation to the median frequency during the fatigue test, there was a decrease in all groups, however with no differences between them. We suggest that LLLT being applied prior to exercise can reduce the fatigue index in the ankle plantar flexors of healthy subjects.

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Photobiomodulation therapy (PBMT) and/or cryotherapy in skeletal muscle restitution, what is better? A randomized, double-blinded, placebo-controlled clinical trial.

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Cryotherapy for post-exercise recovery remains widely used despite the lack of quality evidence. Photobiomodulation therapy (PBMT) studies (with both low-level laser therapy and light-emitting diode therapy) have demonstrated positive scientific evidence to suggest its use. The study aims to evaluate PBMT and cryotherapy as a single or combined treatment on skeletal muscle recovery after eccentric contractions of knee extensors. Fifty healthy male volunteers were recruited and randomized into five groups (PBMT, cryotherapy, cryotherapy + PBMT, PMBT + cryotherapy, or placebo) for a randomized, double-blinded, placebo-controlled trial that evaluated exercise performance (maximum voluntary contraction (MVC)), delayed onset muscle soreness (DOMS), and muscle damage (creatine kinase (CK)). Assessments were performed at baseline; immediately after; and at 1, 24, 48, 72, and 96 h. Comparator treatments was performed 3 min after exercise and repeated at 24, 48, and 72 h. PBMT was applied employing a cordless, portable GameDay device (combination of 905 nm super-pulsed laser and 875- and 640-nm light-emitting diodes (LEDs); manufactured by Multi Radiance Medical, Solon - OH, USA), and cryotherapy by flexible rubber ice packs. PBMT alone was optimal for post-exercise recovery with improved MVC, decreased DOMS, and CK activity ($p < 0.05$) from 24 to 96 h compared to placebo, cryotherapy, and cryotherapy + PBMT. In the PBMT + cryotherapy group, the effect of PBMT was decreased ($p > 0.05$) but demonstrated significant improvement in MVC, decreased DOMS, and CK activity ($p < 0.05$). Cryotherapy as single treatment and cryotherapy + PBMT were similar to placebo ($p > 0.05$). We conclude that PBMT used as single treatment is the best modality for enhancement of post-exercise restitution, leading to complete recovery to baseline levels from 24 h after high-intensity eccentric contractions.

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Pre-Exercise Infrared Low-Level Laser Therapy (810 nm) in Skeletal Muscle Performance and Postexercise Recovery in Humans, What Is the Optimal Dose? A Randomized, Double-Blind, Placebo-Controlled Clinical Trial.

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AIM: This study aimed to evaluate the medium-term effects of low-level laser therapy (LLLT or photobiomodulation) in postexercise skeletal muscle recovery and performance enhancement and to identify the optimal dose of 810 nm LLLT. MATERIALS AND METHODS: A randomized, double-blind, placebo-controlled trial was performed, with voluntary participation of 28 high-level soccer athletes. We analyzed maximum voluntary contraction (MVC), delayed onset muscle soreness (DOMS), creatine kinase (CK) activity, and interleukin-6 (IL-6) expression. The assessments were performed before exercise protocols, after 1 min, and 1, 24, 48, 72, and 96 h after the end of eccentric exercise protocol used to induce fatigue. LLLT was applied before eccentric exercise protocol with a cluster with five diodes, and dose of 10, 30, or 50 J (200 mW and 810 nm) in six sites of quadriceps. RESULTS: LLLT increased ($p < 0.05$) MVC from immediately after exercise to 24 h with 50 J dose, and from 24 to 96 h with 10 J dose. Both 10 J then 50 J dose decreased ($p < 0.05$) CK and IL-6 with better results in favor of 50 J dose. However, LLLT had no effect in decreasing DOMS. No differences ($p > 0.05$) were found for 30 J dose in any of the outcomes measured. CONCLUSION: Pre-exercise LLLT, mainly with 50 J dose, significantly increases performance and improves biochemical markers related to skeletal muscle damage and inflammation.

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Identifying dosage effect of LEDT on muscular fatigue in quadriceps.

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The purpose of this study was to compare the effects of various dosages of light emitting diode therapy (LEDT) on muscle fatigue, while performing a single leg extension to exhaustion. A total of 34 recreationally resistance trained athletes between the ages of 18 and 26 participated in four trials. Each trial included pre/post exercise blood lactate measurements and two sets of three maximal voluntary isometric contractions (MVIC), followed by LEDT on six points across the superficial quadriceps. Each randomized trial consisted of a placebo, 30 seconds, 60 seconds or 120 seconds on each point on the quadriceps. Three minutes after LEDT, the participants performed an eccentric leg extension with 120% of MVIC until fatigue. There was significant increase in the number of repetitions performed between the placebo treatment and 60 seconds (p= 0.023), as well as placebo and 120 seconds (p=0.004) of irradiation on each point. There were no significant differences in blood lactate levels between any of the four trials. In conclusion, light emitting diode therapy had a positive effect on performance when irradiating six points on the superficial quadriceps for 60 seconds and 120 seconds prior to an eccentric leg extension.

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Photobiomodulation delays the onset of skeletal muscle fatigue in a dose-dependent manner.

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Photobiomodulation (PBM) therapy has been implicated as an effective ergogenic aid to delay the onset of muscle fatigue. The purpose of this study was to examine the dose-response ergogenic properties of PBM therapy and its ability to prolong time to task failure by enhancing muscle activity and delaying the onset of muscle fatigue using a static positioning task. Nine participants (24.3 +/- 4.9 years) received three doses of near-infrared (NIR) light therapy randomly on three separate sessions (sham, 240, and 480 J). For the positioning task, participants held a 30 % one-repetition maximum (1-RM) load using the index finger until volitional fatigue. Surface electromyography (sEMG) of the first dorsal interosseous muscle was recorded for the length of the positioning task. Outcomes included time to task failure (TTF), muscle fatigue, movement accuracy, motor output variability, and muscle activity (sEMG). The 240-J dose significantly extended TTF by 26 % ($p = 0.032$) compared with the sham dose. TTF for the 240-J dose was strongly associated with a decrease in muscle fatigue ($R 2 = 0.54$, $p = 0.024$). Our findings show that a 240-J dose of NIR light therapy is efficacious in delaying the onset and extent of muscle fatigue during submaximal isometric positioning tasks. Our findings suggest that NIR light therapy may be used as an ergogenic aid during functional tasks or post-injury rehabilitation.

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Low level laser therapy associated with a strength training program on muscle performance in elderly women: a randomized double blind control study.

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The aging process leads to a gradual loss of muscle mass and muscle performance, leading to a higher functional dependence. Within this context, many studies have demonstrated the benefits of a combination of physical exercise and low level laser therapy (LLLT) as an intervention that enhances muscle performance in young people and athletes. The aim of this study was to evaluate the effects of combination of LLLT and strength training on muscle performance in elderly women. For this, a hundred elderly women were screened, and 48 met all inclusion criteria to participate in this double-blind placebo-controlled trial. Volunteers were divided in three groups: control (CG = 15), strength training associated with placebo LLLT (TG = 17), and strength training associated with active LLLT (808 nm, 100 mW, 7 J) (TLG = 16). The strength training consisted of knee flexion-extension performed with 80 % of 1-repetition maximum (1-RM) during 8 weeks. Several outcomes related to muscle performance were analyzed through the 6-min walk test (6-MWT), isokinetic dynamometry, surface electromyography (SEMG), lactate concentration, and 1-RM. The results revealed that a higher work ($p = 0.0162$), peak torque ($p = 0.0309$), and power ($p = 0.0223$) were observed in TLG compared to CG. Furthermore, both trained groups increased the 1-RM load (TG vs CG: $p = 0.0067$ and TLG vs CG: $p < 0.0001$) and decreased the lactate concentration in the third minute after isokinetic protocol (CG vs TLG: $p = 0.0289$ and CG vs TG: $p = 0.0085$). No difference in 6-MWT and in fatigue levels were observed among the groups. The present findings suggested that LLLT in combination with strength training was able to improve muscle performance in elderly people.

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Acute effects of low-level laser therapy irradiation on blood lactate and muscle fatigue perception in hospitalized patients with heart failure-a pilot study.

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The objective of the present study is to evaluate the acute effects of low-level laser therapy (LLLT) on functional capacity, perceived exertion, and blood lactate in hospitalized patients with heart failure (HF). Patients diagnosed with systolic HF (left ventricular ejection fraction <45 %) were randomized and allocated prospectively into two groups: placebo LLLT group (n = 10)-subjects who were submitted to placebo laser and active LLLT group (n = 10)-subjects who were submitted to active laser. The 6-min walk test (6MWT) was performed, and blood lactate was determined at rest (before LLLT application and 6MWT), immediately after the exercise test (time 0) and recovery (3, 6, and 30 min). A multi-diode LLLT cluster probe (DMC, Sao Carlos, Brazil) was used. Both groups increased 6MWT distance after active or placebo LLLT application compared to baseline values ($p = 0.03$ and $p = 0.01$, respectively); however, no difference was observed during intergroup comparison. The active LLLT group showed a significant reduction in the perceived exertion Borg (PEB) scale compared to the placebo LLLT group ($p = 0.006$). In addition, the group that received active LLLT showed no statistically significant difference for the blood lactate level through the times analyzed. The placebo LLLT group demonstrated a significant increase in blood lactate between the rest and recovery phase ($p < 0.05$). Acute effects of LLLT irradiation on skeletal musculature were not able to improve the functional capacity of hospitalized patients with HF, although it may favorably modulate blood lactate metabolism and reduce perceived muscle fatigue.

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Effects of Light-Emitting Diode Therapy on Muscle Hypertrophy, Gene Expression, Performance, Damage, and Delayed-Onset Muscle Soreness: Case-control Study with a Pair of Identical Twins.

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OBJECTIVE: The aim of this study was to verify how a pair of monozygotic twins would respond to light-emitting diode therapy (LEDT) or placebo combined with a strength-training program during 12 weeks. DESIGN: This case-control study enrolled a pair of male monozygotic twins, allocated randomly to LEDT or placebo therapies. Light-emitting diode therapy or placebo was applied from a flexible light-emitting diode array (lambda = 850 nm, total energy = 75 J, t = 15 seconds) to both quadriceps femoris muscles of each twin immediately after each strength training session (3 times/wk for 12 weeks) consisting of leg press and leg extension exercises with load of 80% and 50% of the 1-repetition maximum test, respectively. Muscle biopsies, magnetic resonance imaging, maximal load, and fatigue resistance tests were conducted before and after the training program to assess gene expression, muscle hypertrophy and performance, respectively. Creatine kinase levels in blood and visual analog scale assessed muscle damage and delayed-onset muscle soreness, respectively, during the training program. RESULTS: Compared with placebo, LEDT increased the maximal load in exercise and reduced fatigue, creatine kinase, and visual analog scale. Gene expression analyses showed decreases in markers of inflammation (interleukin 1beta) and muscle atrophy (myostatin) with LEDT. Protein synthesis (mammalian target of rapamycin) and oxidative stress defense (SOD2 [mitochondrial superoxide dismutase]) were up-regulated with LEDT, together with increases in thigh muscle hypertrophy. CONCLUSIONS: Light-emitting diode therapy can be useful to reduce muscle damage, pain, and atrophy, as well as to increase muscle mass, recovery, and athletic performance in rehabilitation programs and sports medicine.

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Photobiomodulation therapy (PBMT) improves performance and accelerates recovery of high-level Rugby players in field test: A randomized, crossover, double-blind, placebo-controlled clinical study.

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While growing evidence supports the use of photobiomodulation therapy (PBMT) for performance and recovery enhancement, there have only been laboratory-controlled studies. Therefore, the aim of this study was to analyze the effects of PBMT in performance and recovery of high-level rugby players during an anaerobic field test. Twelve male high-level rugby athletes were recruited in this randomized, crossover, double-blinded, placebo-controlled trial. No interventions were performed before the Bangsbo Sprint Test (BST) at familiarization phase (week 1), at weeks 2 and 3 pre-exercise PBMT or placebo were randomly applied to each athlete. PBMT irradiation was performed at 17 sites of each lower limb, employing a cluster with 12 diodes (4 laser diodes of 905nm, 4 LED diodes of 875nm, and 4 LED diodes of 640nm, 30J per site - manufactured by Multi Radiance Medical). Average time of sprints, best time of sprints, and fatigue index were obtained from BST. Blood lactate levels were assessed at baseline, and at 3, 10, 30 and 60 minutes after BST. Athletes' perceived fatigue was also assessed through a questionnaire. PBMT significantly ($p<0.05$) improved average time of sprints and fatigue index in BST. PBMT significantly decreased percentage of change in blood lactate levels ($p<0.05$) and perceived fatigue ($p<0.05$). Pre-exercise PBMT with the combination of super-pulsed laser (low-level laser), red and infrared LEDs can enhance performance and accelerate recovery of high-level rugby players in field test. This opens a new avenue for wide use of PBMT in real clinical practice in sports settings.

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[Restoration of the complicated locomotor functions of the upper extremities in the patients surviving ischemic stroke].

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During the late and residual periods of stroke, it is necessary to pay attention to the training of complex spatial movements along with the traditional restoration of the balance and strength of para-articular muscles and the mobility of the paretic limb joints. The objective of the present study was to evaluate the effectiveness of robotic therapy for the recovery of the functions of the upper extremities in the late and residual periods of stroke. The study involved 52 patients who had survived ischemic stroke in the middle cerebral artery. The patients were divided randomly into 2 groups. All of them performed therapeutic physical exercises based on the standard technique during 5 days a week for 3 weeks. In addition, the treatment included massage, laser and pulsed current therapy. The patients of the main group (n=36) were additionally trained to perform complex spatial movements with special emphasis on their speed, fluidity, precision, and agility with the use of the Multi Joint System (MJS) robotic electromechanical device (40 min, 5 days/wk x 3wk). The analysis of the results of the study has demonstrated the statistically significant difference in the degree of improvement of the range of motion (ROM) in the elbow and shoulder joints, the speed and the accuracy of these movements between the patients of the main and control groups. It is concluded that the instrumental restoration of complex spatial movements of the upper extremities during the late and residual periods of stroke contributes not only to the improvement of the functional capabilities but also to the enhancement of independence and personal adjustment of the stroke patients.

Vopr Kurortol Fizioter Lech Fiz Kult 2016 Jan-Feb 93(1) 11-5

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Effects of photobiomodulation on the fatigue level in elderly women: an isokinetic dynamometry evaluation.

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Aging is responsible by a series of morphological and functional modifications that lead to a decline of muscle function, particularly in females. Muscle tissue in elderly people is more susceptible to fatigue and, consequently, to an increased inability to maintain strength and motor control. In this context, therapeutic approaches able of attenuating muscle fatigue have been investigated. Among these, the photobiomodulation demonstrate positive results to interacts with biological tissues, promoting the increase in cell energy production. Thus, the aim of this study was to investigate the effects of photobiomodulation (808 nm, 250 J/cm2, 100 mW, 7 J each point) in the fatigue level and muscle performance in elderly women. Thirty subjects entered a crossover randomized double-blinded placebo-controlled trial. Photobiomodulation was delivered on the rectus femoris muscle of the dominant limb immediately before the fatigue protocol. In both sessions, peripheral muscle fatigue was analyzed by surface electromyography (EMG) and blood lactate analysis. Muscle performance was evaluated using an isokinetic dynamometer. The results showed that photobiomodulation was able of reducing muscle fatigue by a significant increase of electromyographic fatigue index (EFI) ($p = 0.047$) and decreasing significantly lactate concentration 6 min after the performance of the fatigue protocol ($p = 0. 0006$) compared the placebo laser session. However, the photobiomodulation was not able of increasing muscle performance measured by the isokinetic dynamometer. Thus, it can be conclude that the photobiomodulation was effective in reducing fatigue levels. However, no effects of photobiomodulation on muscle performance was observed.

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Light-emitting diode therapy (LEDT) before matches prevents increase in creatine kinase with a light dose response in volleyball players.

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Low-level laser (light) therapy (LLLT) has been applied over skeletal muscles before intense exercise (muscular pre-conditioning) in order to reduce fatigue and muscle damage (measured by creatine kinase, CK) in clinical trials. However, previous exercise protocols do not exactly simulate the real muscle demand required in sports. For this reason, the aim of this randomized and double-blind placebo-controlled trial was to investigate whether light-emitting diode therapy (LEDT) applied over the quadriceps femoris muscles, hamstrings, and triceps surae of volleyball players before official matches could prevent muscle damage (CK) with a dose response, establishing a therapeutic window. A professional male volleyball team (12 athletes) was enrolled in this study, and LEDT was applied before 4 matches during a national championship. LEDT used an array of 200 light-emitting diodes (LEDs) arranged in 25 clusters of 4 infrared LEDs (850 +/- 20 nm; 130 mW) and 25 clusters of 4 red LEDs (630 +/- 10 nm; 80 mW). Athletes were randomized to receive one of four different total doses over each muscle group in a double-blind protocol: 105 J (20 s), 210 J (40 s), 315 J (60 s), and placebo (no light for 30 s). CK in blood was assessed 1 h before and 24 h after each match. LEDT at 210 J avoided significant increases in CK (+10 %; P = 0.993) as well as 315 J (+31 %, P = 0.407). Placebo (0 J) allowed a significant increase in CK (+53 %; P = 0.012) as well as LEDT at 105 J (+59 %; P = 0.001). LEDT prevented significant increases of CK in blood in athletes when applied before official matches with a light dose response of 210-315 J, suggesting athletes might consider applying LEDT before competition.

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Muscular pre-conditioning using light-emitting diode therapy (LEDT) for high-intensity exercise: a randomized double-blind placebo-controlled trial with a single elite runner.

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Abstract Recently, low-level laser (light) therapy (LLLT) has been used to improve muscle performance. This study aimed to evaluate the effectiveness of near-infrared light-emitting diode therapy (LEDT) and its mechanisms of action to improve muscle performance in an elite athlete. The kinetics of oxygen uptake (VO2), blood and urine markers of muscle damage (creatine kinase - CK and alanine) and fatigue (lactate) were analyzed. Additionally, some metabolic parameters were assessed in urine using proton nuclear magnetic resonance spectroscopy (1H NMR). A LED cluster with 50 LEDs (lambda = 850 nm; 50 mW 15 s; 37.5 J) was applied on legs, arms and trunk muscles of a single runner athlete 5 min before a high-intense constant workload running exercise on treadmill. The athlete received either Placebo-1-LEDT; Placebo-2-LEDT; or Effective-LEDT in a randomized double-blind placebo-controlled trial with washout period of 7 d between each test. LEDT improved the speed of the muscular VO2 adaptation (approximately -9 s), decreased O2 deficit (approximately -10 L), increased the VO2 from the slow component phase (approximately +348 ml min-1) and increased the time limit of exercise (approximately +589 s). LEDT decreased blood and urine markers of muscle damage and fatigue (CK, alanine and lactate levels). The results suggest that a muscular pre-conditioning regimen using LEDT before intense exercises could modulate metabolic and renal function to achieve better performance.

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Use of Low-Level Laser Therapy (808 nm) to Muscle Fatigue Resistance: A Randomized Double-Blind Crossover Trial.

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Abstract Objective: The purpose of this study was to investigate whether low-level laser (light) therapy (LLLT) can provide fatigue resistance via maximum repetitions (RM) with an isokinetic dynamometer, and decrease electromyography fatigue index (EFI). BACKGROUND DATA: LLLT has been used to increase muscle performance when applied before or after intense exercises. MATERIALS AND METHODS: This study was a randomized, double-blind, crossover trial with placebo. Seven young men (21+/-3 years of age) who were clinically healthy, were allocated into two groups: active laser (LLLT) and placebo laser (Placebo). Both groups were assessed at baseline, at one training session, and at the end of this study. Baseline and final assessments recorded the number of RM of knee flexion-extensions using an isokinetic dynamometer at 60 degrees/sec in conjunction with EFI recorded by median frequency. The training sessions consisted of three sets of 20 RM of knee flexion-extensions using an isokinetic dynamometer at 60 degrees/sec plus LLLT (808 nm, 100 mW, 4 J), or placebo, applied to quadriceps femoris muscles between sets, and after the last series of this exercise. After 1 week (washout period), all volunteers were exchanged among groups and then all assessments were repeated. RESULTS: LLLT group increased RM (52%; p=0.002) with a small EFI for the vastus medialis (p=0.004) and rectus femoris (p=0.004). CONCLUSIONS: These results suggest an increased muscle fatigue resistance when LLLT is applied during rest intervals, and after the last series of intense exercises.

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Effect of low-level laser therapy on muscle adaptation to knee extensor eccentric training.

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PURPOSE: Eccentric training has been popularized for physical conditioning and prevention/rehabilitation of musculoskeletal disorders, especially due to the expressive responses in terms of muscular strength gain. In view of evidence that low-level laser therapy (LLLT) is able to increase exercise performance and accelerate post-exercise recovery, the aim of this study was to verify the effect of LLLT on hypertrophy and strengthening of knee extensor muscles submitted to eccentric training. METHOD: Thirty healthy male subjects were randomized into three groups: Control Group (CG), Training Group (TG) and Training + LLLT Group (TLG). CG received no intervention, while TG and TLG were engaged on an 8-week knee extensor isokinetic eccentric training program. Only subjects from TLG were treated with LLLT (wavelength = 810 nm; power output = 200 mW; total dosage = 240 J) before each training session. Knee extensor muscle thickness and peak torque were assessed through ultrasonography and isokinetic dynamometry, respectively. RESULTS: CG presented no changes in any variable throughout the study, while eccentric training led to significant increases in muscle thickness and peak torque in TG and TLG. Subjects from TLG reached significantly higher percent changes compared to subjects from TG for sum of muscles' thicknesses (15.4 vs. 9.4 %), isometric peak torque (20.5 vs. 13.7 %), and eccentric peak torque (32.2 vs. 20.0 %). CONCLUSION: LLLT applied before eccentric training sessions seems to improve the hypertrophic response and muscular strength gain in healthy subjects.

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Phototherapy with combination of super-pulsed laser and light-emitting diodes is beneficial in improvement of muscular performance (strength and muscular endurance), dyspnea, and fatigue sensation in patients with chronic obstructive pulmonary disease.

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Phototherapy is an electrophysical intervention being considered for the retardation of peripheral muscular fatigue usually observed in chronic obstructive pulmonary disease (COPD). The objective of this study was to evaluate the acute effects of combination of super-pulsed laser and light-emitting diodes phototherapy on isokinetic performance in patients with COPD. Thirteen patients performed muscular endurance tests in an isokinetic dynamometer. The maximum voluntary isometric contraction (MVIC), peak torque (PT), and total work (TW) of the non-dominant lower limb were measured in two visits. The application of phototherapy or placebo (PL) was conducted randomly in six locations of femoral quadriceps muscle by using a cluster of 12 diodes (4 of 905 nm super-pulsed lasers, 0.3125 mW each; 4 of 875 nm LEDs, 17.5 mW each; and 4 of 640 nm LEDs, 15 mW each, manufactured by Multi Radiance Medical). We found statistically significant increases for PT (174.7 +/- 35.7 N . m vs. 155.8 +/- 23.3 N . m, p = 0.003) and TW after application of phototherapy when compared to placebo (778.0 +/- 221.1 J vs. 696.3 +/- 146.8 J, p = 0.005). Significant differences were also found for MVIC (104.8 +/- 26.0 N . m vs. 87.2 +/- 24.0 N . m, p = 0.000), sensation of dyspnea (1 [0-4] vs. 3 [0-6], p = 0.003), and fatigue in the lower limbs (2 [0-5] vs. 5 [0.5-9], p = 0.002) in favor of phototherapy. We conclude that the combination of super-pulsed lasers and LEDs administered to the femoral quadriceps muscle of patients with COPD increased the PT by 20.2 % and the TW by 12 %. Phototherapy with a combination of super-pulsed lasers and LEDs prior to exercise also led to decreased sensation of dyspnea and fatigue in the lower limbs in patients with COPD.

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Near-Infrared Light Therapy to Attenuate Strength Loss After Strenuous Resistance Exercise.

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Context : Near-infrared (NIR) light therapy is purported to act as an ergogenic aid by enhancing the contractile function of skeletal muscle. Improving muscle function is a new avenue for research in the area of laser therapy; however, very few researchers have examined the ergogenic effects of (NIR) light therapy and the influence it may have on the recovery process during rehabilitation. Objective : To evaluate the ergogenic effect of (NIR) light therapy on skeletal muscle function. Design : Crossover study. Setting : Controlled laboratory. Patients or Other Participants : Thirty-nine healthy men (n = 21) and women (n = 18; age = 20.0 +/- 0.2 years, height = 169 +/- 2 cm, mass = 68.4 +/- 1.8 kg, body mass index = 23.8 +/- 0.4 kg/m2). Intervention(s) : Each participant received active and sham treatments on the biceps brachii muscle on 2 separate days. The order of treatment was randomized. A class 4 laser with a cumulative dose of 360 J was used for the active treatment. After receiving the treatment on each day, participants completed an elbow-flexion resistance-exercise protocol. Main Outcome Measure(s) : The dependent variables were elbow range of motion, muscle point tenderness, and strength (peak torque). Analysis of variance with repeated measures was used to assess changes in these measures between treatments at baseline and at follow-up, 48 hours postexercise. Additionally, immediate strength loss postexercise was compared between treatments using a paired t test. Results : Preexercise to postexercise strength loss for the active laser treatment, although small, was less than with the sham treatment (P = .05). Conclusions : Applied to skeletal muscle before resistance exercise, (NIR) light therapy effectively attenuated strength loss. Therefore, NIR light therapy may be a beneficial, noninvasive modality for improving muscle function during rehabilitation after musculoskeletal injury. However, future studies using higher treatment doses are warranted.

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Phototherapy in skeletal muscle performance and recovery after exercise: effect of combination of super-pulsed laser and light-emitting diodes.

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Recent studies with phototherapy have shown positive results in enhancement of performance and improvement of recovery when applied before exercise. However, several factors still remain unknown such as therapeutic windows, optimal treatment parameters, and effects of combination of different light sources (laser and LEDs). The aim of this study was to evaluate the effects of phototherapy with the combination of different light sources on skeletal muscle performance and post-exercise recovery, and to establish the optimal energy dose. A randomized, double-blinded, placebo-controlled trial with participation of 40 male healthy untrained volunteers was performed. A single phototherapy intervention was performed immediately after pre-exercise (baseline) maximum voluntary contraction (MVC) with a cluster of 12 diodes (4 of 905 nm lasers-0.3125 mW each, 4 of 875 nm LEDs-17.5 mW each, and 4 of 670 nm LEDs-15 mW each- manufactured by Multi Radiance Medical) and dose of 10, 30, and 50 J or placebo in six sites of quadriceps. MVC, delayed onset muscle soreness (DOMS), and creatine kinase (CK) activity were analyzed. Assessments were performed before, 1 min, 1, 24, 48, 72, and 96 h after eccentric exercise protocol employed to induce fatigue. Phototherapy increased ($p < 0.05$) MVC was compared to placebo from immediately after to 96 h after exercise with 10 or 30 J doses (better results with 30 J dose). DOMS was significantly decreased compared to placebo ($p < 0.05$) with 30 J dose from 24 to 96 h after exercise, and with 50 J dose from immediately after to 96 h after exercise. CK activity was significantly decreased ($p < 0.05$) compared to placebo with all phototherapy doses from 1 to 96 h after exercise (except for 50 J dose at 96 h). Pre-exercise phototherapy with combination of low-level laser and LEDs, mainly with 30 J dose, significantly increases performance, decreases DOMS, and improves biochemical marker related to skeletal muscle damage.

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Acute effects of low-level laser therapy on physiologic and electromyographic responses to the cardiopulmonary exercise testing in healthy untrained adults.

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Despite the positive effects of low-level laser therapy (LLLT) on muscle fatigue before exercises using a single muscle group, the acute effects of LLLT on performance in cardiopulmonary exercise testing (CPET) are poorly understood. We aimed to assess the acute effects of LLLT on physiologic and electromyographic responses to the CPET in healthy adults. A randomized, double-blind, placebo-controlled crossover trial was performed with 18 untrained participants (nine males, 22 +/- 2 years). We applied LLLT or placebo on quadriceps and gastrocnemius 10 min before two rapidly incremental CPETs randomly performed in alternate days on a cycle ergometer. Participants received LLLT using a multidiode cluster, 20 s/site (850 nm, 100 mW/diode, 14 J/site). Physiological responses to the CPET were continuously monitored using a gas analyzer. The electromyographic fatigue threshold (EMGth) was assessed through surface electrodes on vastus lateralis. The root mean square (RMS) was plotted every 5 s against the exercise intensity, and its breakpoint values throughout the CPET was identified as EMGth. Compared to placebo, the LLLT significantly increased peak O2 uptake (V'O2 33 +/- 10 vs. 31 +/- 9 mL/min/kg). We observed a shallower slope of the Deltaheart rate/DeltaV'O2 during the CPET after LLLT compared to placebo, i.e., increased cardiovascular efficiency (56 +/- 24 vs. 66 +/- 30 bpm/L/min). There were no LLLT-related changes in EMGth. The LLLT acutely increases exercise performance in healthy untrained adults probably due to increased O2 extraction by peripheral muscles without causing a significant impact on muscle fatigue.

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Effects of pre- or post-exercise low-level laser therapy (830 nm) on skeletal muscle fatigue and biochemical markers of recovery in humans: double-blind placebo-controlled trial.

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OBJECTIVES: The purpose of this study was to investigate the effect of low-level laser therapy (LLLT) before and after exercise on quadriceps muscle performance, and to evaluate the changes in serum lactate and creatine kinase (CK) levels. METHODS: The study was randomized, double blind, and placebo controlled. PATIENTS: A sample of 27 healthy volunteers (male soccer players) were divided into three groups: placebo, pre-fatigue laser, and post-fatigue laser. The experiment was performed in two sessions, with a 1 week interval between them. Subjects performed two sessions of stretching followed by blood collection (measurement of lactate and CK) at baseline and after fatigue of the quadriceps by leg extension. LLLT was applied to the femoral quadriceps muscle using an infrared laser device (830 nm), 0.0028 cm(2) beam area, six 60 mW diodes, energy of 0.6 J per diode (total energy to each limb 25.2 J (50.4 J total), energy density 214.28 J/cm(2), 21.42 W/cm(2) power density, 70 sec per leg. We measured the time to fatigue and number and maximum load (RM) of repetitions tolerated. Number of repetitions and time until fatigue were primary outcomes, secondary outcomes included serum lactate levels (measured before and 5, 10, and 15 min after exercise), and CK levels (measured before and 5 min after exercise). RESULTS: The number of repetitions ($p=0.8965$), RM ($p=0.9915$), and duration of fatigue ($p=0.8424$) were similar among the groups. Post-fatigue laser treatment significantly decreased the serum lactate concentration relative to placebo treatment ($p<0.01$) and also within the group over time (after 5 min vs. after 10 and 15 min, $p<0.05$ both). The CK level was lower in the post-fatigue laser group ($p<0.01$). CONCLUSIONS: Laser application either before or after fatigue reduced the post-fatigue concentrations of serum lactate and CK. The results were more pronounced in the post-fatigue laser group.

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Effects of low-level laser therapy on biceps braquialis muscle fatigue in young women.

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OBJECTIVE: This study aims to investigate the effects of low-level laser therapy (LLLT) on biceps brachi muscular fatigue in 20 young females. Background data: Exhausting physical activity leads to muscular fatigue, which could decrease muscular strength, and may cause impairment in motor control and muscle pain. Several biochemical and biophysical resources have been studied in an attempt to accelerate the recovery of muscle fatigue. Among these, LLLT is emphasized. METHODS: Twenty subjects were randomized in one laser group and one placebo group in two sessions of a crossover design experimental procedure; the second session taking place within 7 days of the first. In the first session, subjects underwent a collection of surface electromyographic (SEMG) data of the biceps brachii muscle, followed by active or placebo LLLT at the same muscle, followed then by another EMG sample of biceps brachii. Blood samples were collected five times during the experimental procedure. Second session procedures were identical to the first, with exception of LLLT, which was the opposite of the first session. The fatigue protocol consisted of 60 sec of elbow flexion-extension movement performed with 75% of one maximum repetition. Blood lactate, EMG fatigue, and the number of elbow flexion-extension repetitions during the fatigue protocol were used to evaluate the effects of laser therapy (808 nm wavelength, 100 mW output power, power density of 35.7 W/cm(2), 70 sec each point and 7 J/point on eight points). RESULTS: No statistical differences were found for eletromyographic fatigue and blood lactate values between groups. Mean numbers of elbow flexion-extension repetitions were 22.6 +/- 7.58 after placebo, and 25.1 +/- 9.89 after active LLLT group, but these differences were not statistically significant (p=0.342). CONCLUSIONS: LLLT had limited effects on delaying muscle fatigue in a young female sample, although a tendency was observed in the active laser group toward showing lower electromyography fatigue of biceps brachii muscle. No intergroup differences were found in the number of muscle contractions and lactate concentration.

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Light-emitting diode phototherapy improves muscle recovery after a damaging exercise.

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The goal of the present study was to determine the effect of light-emitting diode phototherapy (LEDT) at 630 nm on muscle recovery after a damaging eccentric exercise bout. Seventeen healthy young male volunteers, without previous experience with eccentric exercise, were included in a randomized double-blinded placebo-controlled trial. They were divided into a LEDT (n = 8) and a PLACEBO group (n = 9). To induce muscle damage, subjects performed 30 eccentric contractions with a load of 100 % of maximal voluntary isometric contraction strength of the elbow flexors of the non-dominant arm. LEDT group subjects received biceps brachii phototherapy (lambda 630 nm; total energy density, 20.4 J/cm2) immediately after the exercise bout. The LEDT in the placebo group was aimed at the muscle, but it remained turned off. Isometric muscle strength, muscle soreness, and elbow range of motion (ROM) were measured before and at 24, 48, 72, and 96 h the after eccentric exercise bout and compared between groups. Our results showed that the muscle soreness, muscle strength loss, and ROM impairments were significantly reduced up to 96 h after a damaging eccentric exercise bout for the LEDT group compared with the PLACEBO group. A single LEDT (630 nm) intervention immediately after a damaging eccentric exercise bout was effective in terms of attenuating the muscle soreness and muscle strength loss and ROM impairments.

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Effect of low-level laser therapy (808 nm) on markers of muscle damage: a randomized double-blind placebo-controlled trial.

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The aim of this randomized double-blind placebo-controlled study was to investigate the effect of low-level laser therapy (LLLT) on markers of muscle damage (creatine kinase (CK) and strength performance) in the biceps brachii. Twenty-two physically active men were randomized into two groups: placebo and laser. All volunteers were submitted to an exercise-induced muscle damage protocol for biceps brachii (biceps curl, 10 sets of 10 repetitions with load of 50 % of one-repetition maximum test (1RM)). Active LLLT (808 nm; 100 mW; 35.7 W/cm2, 357.14 J/cm2 per point, energy of 1 J per point applied for 10 s on four points of the biceps brachii belly of each arm) or placebo was applied between the sets of the biceps curl exercise. CK activity and maximum strength performance (1RM) were measured before, immediately after, 24, 48, and 72 h after the exercise-induced muscle damage protocol. There was an increase in CK activity after the muscle damage protocol in both groups; however, this increase was attenuated in the laser group compared to the placebo group at 72 h (placebo = 841 vs. laser = 357 %; $p < 0.05$). Maximum strength performance was decreased immediately after the muscle damage protocol in both groups ($p < 0.05$), but at 24, 48, and 72 h, and it returned to the baseline level in both groups. In conclusion, the LLLT attenuated CK activity 72 h after the muscle damage protocol but did not have a positive effect on the recovery of strength performance.

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Acute effects of light emitting diodes therapy (LEDT) in muscle function during isometric exercise in patients with chronic obstructive pulmonary disease: preliminary results of a randomized controlled trial.

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Patients with chronic obstructive pulmonary disease (COPD) are susceptible to early muscle fatigue. Light-emitting diodes therapy (LEDT) has been used to minimize muscle fatigue in athletes and healthy subjects. The aim of this study is to investigate the acute effects of LEDT on muscle fatigue and perception of effort in patients with COPD during isometric endurance test of the quadriceps femoris (QF). Ten patients (VEF1 50 +/- 13 % of predicted) underwent a single LEDT and sham application, 48 h apart, in a randomized crossover design. The LEDT and sham were applied in three localized areas of the QF (rectus femoris, vastus lateralis, and vastus medialis). Before and after exposure to LEDT and sham, the patients performed an isometric endurance test (60 % of the maximum voluntary isometric contraction), until the limit of tolerance concomitant to surface electromyography recording (median frequency as mean outcome). The slope obtained from linear regression analysis of the median frequency (MF) over endurance time was also used as an endurance index. Endurance time increased significantly after exposure to LEDT (from 26 +/- 2 to 53 +/- 5 s) as compared to sham (from 23 +/- 3 to 30 +/- 4 s) (F = 64, P = 0.0001). A greater decline in MF was observed during isometric endurance test after sham, compared to LEDT (F = 14.6, P = 0.004). The slope of the MF over time was lower post-LEDT compared to post-sham (-0.7 +/- 0.3 vs. -1.5 +/- 0.8; P = 0.004). The dyspnea score corrected for endurance time was lower post-LEDT (P = 0.008) but similar for fatigue both post-LEDT and post-sham. A single application of LEDT minimizes muscle fatigue and increases isometric endurance time.

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Effect of 808 nm low-level laser therapy in exercise-induced skeletal muscle fatigue in elderly women.

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Aging process involves several structural changes in muscle tissue which lead to decrease in musculoskeletal function. One of the most common physiological modifications is the increase in fatigability in elderly people, which leads to inability to maintain strength and motor control. In this context, low-level laser therapy (LLLT) has demonstrated positive results in reducing fatigue during physical exercise. Thus, this study aimed to investigate the effects of LLLT on skeletal muscle fatigue in elderly women. Twenty-four subjects divided in two groups entered a crossover randomized triple-blinded placebo-controlled trial. Active LLLT (808 nm wavelength, 100 mW, energy 7 J) or an identical placebo LLLT was delivered on the rectus femoris muscle immediately before a fatigue protocol. Subjects performed a fatigue protocol which consisted of voluntary isotonic contractions of knee flexion-extension performed with a load corresponding to 75 % of 1-MR (Maximum Repetition) during 60 s. Surface electromyography (SEMG) signals were recorded from rectus femoris muscle of dominant lower limb to evaluate peripheral fatigability using median frequency analysis of SEMG signal. The number of repetitions of flexion-extension during fatigue protocol was also compared between groups. The values of median frequency were used to calculate the slope coefficient. The results showed no difference in the slope comparing placebo LLLT and active LLLT groups ($p = 0.293$). However, a significant difference was observed in the number of repetitions between groups, after active LLLT, subjects demonstrated significantly higher number of repetitions ($p = 0.047$). In this study, LLLT was efficient in increasing the mean number of repetitions during knee flexion-extension exercise, although results have not shown delay electromyographic fatigue.

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Infrared LED irradiation applied during high-intensity treadmill training improves maximal exercise tolerance in postmenopausal women: a 6-month longitudinal study.

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Reduced aerobic fitness is associated with an increased risk of cardiovascular diseases among the older population. The aim of this study was to investigate the effects of LED irradiation (850 nm) applied during treadmill training on the maximal exercise tolerance in postmenopausal women. At the beginning of the study, 45 postmenopausal women were assigned randomly to three groups, and 30 women completed the entire 6 months of the study. The groups were: (1) the LED group (treadmill training associated with phototherapy, n = 10), (2) the exercise group (treadmill training, n = 10), and (3) the sedentary group (neither physical training nor phototherapy, n = 10). The training was performed for 45 min twice a week for 6 months at intensities between 85% and 90% maximal heart rate (HR(max)). The irradiation parameters were 39 mW/cm(2), 45 min and 108 J/cm(2). The cardiovascular parameters were measured at baseline and after 6 months. As expected, no significant differences were found in the sedentary group ($p >/= 0.05$). The maximal time of tolerance (Tlim), metabolic equivalents (METs) and Bruce stage reached significantly higher values in the LED group and the exercise group ($p < 0.01$). Furthermore, the HR, double product and Borg score at isotime were significantly lower in the LED group and in the exercise group ($p < 0.05$). However, the time of recovery showed a significant decrease only in the LED group ($p = 0.003$). Moreover, the differences between before and after training (delta values) for the Tlim, METs and HR at isotime were greater in the LED group than in the exercise group with a significant intergroup difference ($p < 0.05$). Therefore, the infrared LED irradiation during treadmill training can improve maximal performance and post-exercise recovery in postmenopausal women.

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Effects of low-level laser therapy (808 nm) on isokinetic muscle performance of young women submitted to endurance training: a randomized controlled clinical trial.

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Low-level laser therapy (LLLT) has shown efficacy in muscle bioenergetic activation and its effects could influence the mechanical performance of this tissue during physical exercise. This study tested whether endurance training associated with LLLT could increase human muscle performance in isokinetic dynamometry when compared to the same training without LLLT. The primary objective was to determine the fatigue index of the knee extensor muscles (FIext) and the secondary objective was to determine the total work of the knee extensor muscles (TWext). Included in the study were 45 clinically healthy women (21 +/- 1.78 years old) who were randomly distributed into three groups: CG (control group), TG (training group) and TLG (training with LLLT group). The training for the TG and TLG groups involved cycle ergometer exercise with load applied to the ventilatory threshold (VT) for 9 consecutive weeks. Immediately after each training session, LLLT was applied to the femoral quadriceps muscle of both lower limbs of the TLG subjects using an infrared laser device (808 nm) with six 60-mW diodes with an energy of 0.6 J per diode and a total energy applied to each limb of 18 J. VT was determined by ergospirometry during an incremental exercise test and muscle performance was evaluated using an isokinetic dynamometer at 240 degrees /s. Only the TLG showed a decrease in FIext in the nondominant lower limb ($P = 0.016$) and the dominant lower limb ($P = 0.006$). Both the TLG and the TG showed an increase in TWext in the nondominant lower limb ($P < 0.001$ and $P = 0.011$, respectively) and in the dominant lower limb ($P < 0.000$ and $P < 0.000$, respectively). The CG showed no reduction in FIext or TWext in either lower limb. The results suggest that an endurance training program combined with LLLT leads to a greater reduction in fatigue than an endurance training program without LLLT. This is relevant to everyone involved in sport and rehabilitation.

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Red (660 nm) and infrared (830 nm) low-level laser therapy in skeletal muscle fatigue in humans: what is better?

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In animal and clinical trials low-level laser therapy (LLLT) using red, infrared and mixed wavelengths has been shown to delay the development of skeletal muscle fatigue. However, the parameters employed in these studies do not allow a conclusion as to which wavelength range is better in delaying the development of skeletal muscle fatigue. With this perspective in mind, we compared the effects of red and infrared LLLT on skeletal muscle fatigue. A randomized double-blind placebo-controlled crossover trial was performed in ten healthy male volunteers. They were treated with active red LLLT, active infrared LLLT (660 or 830 nm, 50 mW, 17.85 W/cm(2), 100 s irradiation per point, 5 J, 1,785 J/cm(2) at each point irradiated, total 20 J irradiated per muscle) or an identical placebo LLLT at four points of the biceps brachii muscle for 3 min before exercise (voluntary isometric elbow flexion for 60 s). The mean peak force was significantly greater ($p < 0.05$) following red (12.14%) and infrared LLLT (14.49%) than following placebo LLLT, and the mean average force was also significantly greater ($p < 0.05$) following red (13.09%) and infrared LLLT (13.24%) than following placebo LLLT. There were no significant differences in mean average force or mean peak force between red and infrared LLLT. We conclude that both red than infrared LLLT are effective in delaying the development skeletal muscle fatigue and in enhancement of skeletal muscle performance. Further studies are needed to identify the specific mechanisms through which each wavelength acts.

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Effects of infrared-LED illumination applied during high-intensity treadmill training in postmenopausal women.

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BACKGROUND DATA: Technology and physical exercise can enhance physical performance during aging. OBJECTIVE: The purpose of this study was to investigate the effects of infrared-light-emitting diode (LED) illumination (850 nm) applied during treadmill training. MATERIALS AND METHODS: Twenty postmenopausal women participated in this study. They were randomly divided into two groups. The LED group performed treadmill training associated with infrared-LED illumination (n=10) and the control group performed only treadmill training (n=10). The training was performed during 3 months, twice a week during 30 min at intensities between 85 and 90% of maximal heart rate. The irradiation parameters were 31 mW/cm(2), treatment time 30 min, 14,400 J of total energy and 55.8 J/cm(2) of fluence. Physiological, biomechanical, and body composition parameters were measured at the baseline and after 3 months. RESULTS: Both groups improved the time of tolerance limit (Tlim) ($p<0.05$) during submaximal constant-speed testing. The peak torque did not differ between groups. However, the results showed significantly higher values of power [from 56+/-10 to 73+/-8 W ($p=0.002$)] and total work [from 1,537+/-295 to 1,760+/-262 J ($p=0.006$)] for the LED group when compared to the control group [power: from 58+/-14 to 60+/-15 W ($p>/=0.05$) and total work: from 1,504+/-404 to 1,622+/-418 J ($p>/=0.05$)]. The fatigue significantly increased for the control group [from 51+/-6 to 58+/-5 % ($p=0.04$)], but not for the LED group [from 60+/-10 to 60+/-4 % ($p>/=0.05$)]. No significant differences in body composition were observed for either group. CONCLUSIONS: Infrared-LED illumination associated with treadmill training can improve muscle power and delay leg fatigue in postmenopausal women.

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Low-level laser therapy (LLLT) in human progressive-intensity running: effects on exercise performance, skeletal muscle status, and oxidative stress.

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The aim of this work was to evaluate the effects of low-level laser therapy (LLLT) on exercise performance, oxidative stress, and muscle status in humans. A randomized double-blind placebo-controlled crossover trial was performed with 22 untrained male volunteers. LLLT (810 nm, 200 mW, 30 J in each site, 30 s of irradiation in each site) using a multi-diode cluster (with five spots - 6 J from each spot) at 12 sites of each lower limb (six in quadriceps, four in hamstrings, and two in gastrocnemius) was performed 5 min before a standardized progressive-intensity running protocol on a motor-drive treadmill until exhaustion. We analyzed exercise performance (VO(2 max), time to exhaustion, aerobic threshold and anaerobic threshold), levels of oxidative damage to lipids and proteins, the activities of the antioxidant enzymes superoxide dismutase (SOD) and catalase (CAT), and the markers of muscle damage creatine kinase (CK) and lactate dehydrogenase (LDH). Compared to placebo, active LLLT significantly increased exercise performance (VO(2 max) $p = 0.01$; time to exhaustion, $p = 0.04$) without changing the aerobic and anaerobic thresholds. LLLT also decreased post-exercise lipid ($p = 0.0001$) and protein ($p = 0.0230$) damages, as well as the activities of SOD ($p = 0.0034$), CK ($p = 0.0001$) and LDH ($p = 0.0001$) enzymes. LLLT application was not able to modulate CAT activity. The use of LLLT before progressive-intensity running exercise increases exercise performance, decreases exercise-induced oxidative stress and muscle damage, suggesting that the modulation of the redox system by LLLT could be related to the delay in skeletal muscle fatigue observed after the use of LLLT.

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Comparison between cold water immersion therapy (CWIT) and light emitting diode therapy (LEDT) in short-term skeletal muscle recovery after high-intensity exercise in athletes-preliminary results.

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In the last years, phototherapy has becoming a promising tool to improve skeletal muscle recovery after exercise, however, it was not compared with other modalities commonly used with this aim. In the present study we compared the short-term effects of cold water immersion therapy (CWIT) and light emitting diode therapy (LEDT) with placebo LEDT on biochemical markers related to skeletal muscle recovery after high-intensity exercise. A randomized double-blind placebo-controlled crossover trial was performed with six male young futsal athletes. They were treated with CWIT (5 degrees C of temperature [SD +/-1 degrees]), active LEDT (69 LEDs with wavelengths 660/850 nm, 10/30 mW of output power, 30 s of irradiation time per point, and 41.7 J of total energy irradiated per point, total of ten points irradiated) or an identical placebo LEDT 5 min after each of three Wingate cycle tests. Pre-exercise, post-exercise, and post-treatment measurements were taken of blood lactate levels, creatine kinase (CK) activity, and C-reactive protein (CRP) levels. There were no significant differences in the work performed during the three Wingate tests ($p > 0.05$). All biochemical parameters increased from baseline values ($p < 0.05$) after the three exercise tests, but only active LEDT decreased blood lactate levels ($p = 0.0065$) and CK activity ($p = 0.0044$) significantly after treatment. There were no significant differences in CRP values after treatments. We concluded that treating the leg muscles with LEDT 5 min after the Wingate cycle test seemed to inhibit the expected post-exercise increase in blood lactate levels and CK activity. This suggests that LEDT has better potential than 5 min of CWIT for improving short-term post-exercise recovery.

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Effects of low level laser therapy (808 nm) on physical strength training in humans.

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Recent studies have investigated whether low level laser therapy (LLLT) can optimize human muscle performance in physical exercise. This study tested the effect of LLLT on muscle performance in physical strength training in humans compared with strength training only. The study involved 36 men (20.8+/-2.2 years old), clinically healthy, with a beginner and/or moderate physical activity training pattern. The subjects were randomly distributed into three groups: TLG (training with LLLT), TG (training only) and CG (control). The training for TG and TLG subjects involved the leg-press exercise with a load equal to 80% of one repetition maximum (1RM) in the leg-press test over 12 consecutive weeks. The LLLT was applied to the quadriceps muscle of both lower limbs of the TLG subjects immediately after the end of each training session. Using an infrared laser device (808 nm) with six diodes of 60 mW each a total energy of 50.4 J of LLLT was administered over 140 s. Muscle strength was assessed using the 1RM leg-press test and the isokinetic dynamometer test. The muscle volume of the thigh of the dominant limb was assessed by thigh perimetry. The TLG subjects showed an increase of 55% in the 1RM leg-press test, which was significantly higher than the increases in the TG subjects (26%, $P = 0.033$) and in the CG subjects (0.27%, $P < 0.001$). The TLG was the only group to show an increase in muscle performance in the isokinetic dynamometry test compared with baseline. The increases in thigh perimeter in the TLG subjects and TG subjects were not significantly different (4.52% and 2.75%, respectively; $P = 0.775$). Strength training associated with LLLT can increase muscle performance compared with strength training only.

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Effect of Light-Emitting Diodes Therapy (LEDT) on Knee Extensor Muscle Fatigue.

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Abstract Objective: The purpose of this study was to evaluate the effects of light-emitting diodes therapy (LEDT) on quadriceps muscle fatigue by using torque values from the isokinetic dynamometer as an outcome measure. Background Data: Light therapy is considered an innovative way to prevent muscle fatigue. Although positive results have been obtained in animal models and in clinical experiments, no results are available on the effects of this therapeutic modality on human performance studies with isokinetic dynamometry. Materials and Methods: Seventeen healthy and physically active male volunteers were included in a crossover randomized double-blinded placebo-controlled trial. They performed two sessions of an isokinetic fatigue test (30 maximal concentric knee flexion-extension contractions; range of motion, 90 degrees; angular velocity, 180 degrees per second) after LEDT or placebo treatment. Maximal knee extensor muscle isokinetic voluntary contractions were performed before (PRE-MVC) and after (POST-MVC) the fatigue test. LEDT treatment was performed with a multidiode cluster probe (34 red diodes of 660 nm, 10 mW; 35 infrared diodes of 850 nm, 30 mW) at three points of the quadriceps muscle, with a total irradiating dose of 125.1 J. Results: No differences were observed in the PRE-MVC between LEDT (284.81 +/- 4.52 Nm) and placebo (282.65 +/- 52.64 Nm) treatments. However, for the POST-MVC, higher torques (p = 0.034) were observed for LEDT (237.68 +/- 48.82 Nm) compared with placebo (225.68 +/- 44.14 Nm) treatment. Conclusion: LEDT treatment produced a smaller maximal isometric torque decrease after high-intensity concentric isokinetic exercise, which is consistent with an increase in performance.

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Effects of Low-Level Laser Therapy (LLLT) in the Development of Exercise-Induced Skeletal Muscle Fatigue and Changes in Biochemical Markers Related to Post-Exercise Recovery.

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STUDY DESIGN: Randomized crossover double-blinded placebo-controlled trial. OBJECTIVE: To investigate if low level laser therapy (LLLT) can affect biceps muscle performance, fatigue development, and biochemical markers of post-exercise recovery. BACKGROUND: Cell and animal studies have suggested that LLLT can reduce oxidative stress and inflammatory responses in muscle tissue. But it remains uncertain whether these findings can translate into humans in sport and exercise situations. METHODS: Nine healthy male volleyball players participated in the study. They received either active LLLT (cluster probe with 5 laser diodes, l=810 nm, 200 mW power output, 30 seconds of irradiation, applied in 2 locations over the biceps of the non-dominant arm, 60 J of total energy) or placebo LLLT using an identical cluster probe. The intervention or placebo were applied 3 minutes before the performance of exercise. All subjects performed voluntary elbow flexion repetitions with a workload of 75% of their maximal voluntary contraction force (MVC) until exhaustion. RESULTS: Active LLLT increased the number of repetitions by 14.5% (mean of 39.56, SD +/- 4.33 versus 34.56 +/- 5.64, p=0.037) and the elapsed time before exhaustion by 8.0% (p=0.034), when compared to the placebo treatment. The biochemical markers also indicated that recovery may be positively affected by LLLT as indicated by post-exercise blood lactate levels (p<0.01), Creatine Kinase (CK) activity (p=0.017), and C-Reactive Protein (CRP) levels (p=0.047) showing a faster recovery with LLLT application prior to the exercise. CONCLUSION: We conclude that pre-exercise irradiation of the biceps with an LLLT dose of 6 J per application location, applied in 2 locations, increased endurance for repeated elbow flexion against resistance, and decreased post-exercise levels of blood lactate, CK, and CRP. LEVEL OF EVIDENCE: Therapy, Level 1a. J Orthop Sports Phys Ther, Epub 12 April 2010. doi:10.2519/jospt.2010.3294.

J Orthop Sports Phys Ther 2010 Apr 12

http://www.ncbi.nlm.nih.gov/pubmed/?term=20436237

Effect of cluster multi-diode light emitting diode therapy (LEDT) on exercise-induced skeletal muscle fatigue and skeletal muscle recovery in humans.

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BACKGROUND AND OBJECTIVES: There are some indications that low-level laser therapy (LLLT) may delay the development of skeletal muscle fatigue during high-intensity exercise. There have also been claims that LED cluster probes may be effective for this application however there are differences between LED and laser sources like spot size, spectral width, power output, etc. In this study we wanted to test if light emitting diode therapy (LEDT) can alter muscle performance, fatigue development and biochemical markers for skeletal muscle recovery in an experimental model of biceps humeri muscle contractions. STUDY DESIGN/MATERIALS AND METHODS: Ten male professional volleyball players (23.6 [SD +/-5.6] years old) entered a randomized double-blinded placebo-controlled crossover trial. Active cluster LEDT (69 LEDs with wavelengths 660/850 nm, 10/30 mW, 30 seconds total irradiation time, 41.7 J of total energy irradiated) or an identical placebo LEDT was delivered under double-blinded conditions to the middle of biceps humeri muscle immediately before exercise. All subjects performed voluntary biceps humeri contractions with a workload of 75% of their maximal voluntary contraction force (MVC) until exhaustion. RESULTS: Active LEDT increased the number of biceps humeri contractions by 12.9% (38.60 [SD +/-9.03] vs. 34.20 [SD +/-8.68], P = 0.021) and extended the elapsed time to perform contractions by 11.6% (P = 0.036) versus placebo. In addition, post-exercise levels of biochemical markers decreased significantly with active LEDT: Blood Lactate (P = 0.042), Creatine Kinase (P = 0.035), and C-Reative Protein levels (P = 0.030), when compared to placebo LEDT. CONCLUSION: We conclude that this particular procedure and dose of LEDT immediately before exhaustive biceps humeri contractions, causes a slight delay in the development of skeletal muscle fatigue, decreases post-exercise blood lactate levels and inhibits the release of Creatine Kinase and C-Reative Protein. Lasers Surg. Med. (c) 2009 Wiley-Liss, Inc.

Lasers Surg Med 2009 Sep 3

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Comparison Between Single-Diode Low-Level Laser Therapy (LLLT) and LED Multi-Diode (Cluster) Therapy (LEDT) Applications Before High-Intensity Exercise.

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Abstract Background Data and Objective: There is anecdotal evidence that low-level laser therapy (LLLT) may affect the development of muscular fatigue, minor muscle damage, and recovery after heavy exercises. Although manufacturers claim that cluster probes (LEDT) maybe more effective than single-diode lasers in clinical settings, there is a lack of head-to-head comparisons in controlled trials. This study was designed to compare the effect of single-diode LLLT and cluster LEDT before heavy exercise. Materials and Methods: This was a randomized, placebo-controlled, double-blind cross-over study. Young male volleyball players (n = 8) were enrolled and asked to perform three Wingate cycle tests after 4 x 30 sec LLLT or LEDT pretreatment of the rectus femoris muscle with either (1) an active LEDT cluster-probe (660/850 nm, 10/30 mW), (2) a placebo cluster-probe with no output, and (3) a single-diode 810-nm 200-mW laser. Results: The active LEDT group had significantly decreased post-exercise creatine kinase (CK) levels (-18.88 +/- 41.48 U/L), compared to the placebo cluster group (26.88 +/- 15.18 U/L) ($p < 0.05$) and the active single-diode laser group (43.38 +/- 32.90 U/L) ($p < 0.01$). None of the pre-exercise LLLT or LEDT protocols enhanced performance on the Wingate tests or reduced post-exercise blood lactate levels. However, a non-significant tendency toward lower post-exercise blood lactate levels in the treated groups should be explored further. Conclusion: In this experimental set-up, only the active LEDT probe decreased post-exercise CK levels after the Wingate cycle test. Neither performance nor blood lactate levels were significantly affected by this protocol of pre-exercise LEDT or LLLT.

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Effect of 830 nm low-level laser therapy applied before high-intensity exercises on skeletal muscle recovery in athletes.

Leal Junior EC, Lopes-Martins RA, Baroni BM, De Marchi T, Taufer D, Manfro DS, Rech M, Danna V, Grosselli D, Generosi RA, Marcos RL, Ramos L, Bjordal JM

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Our aim was to investigate the immediate effects of bilateral, 830 nm, low-level laser therapy (LLLT) on high-intensity exercise and biochemical markers of skeletal muscle recovery, in a randomised, double-blind, placebo-controlled, crossover trial set in a sports physiotherapy clinic. Twenty male athletes (nine professional volleyball players and eleven adolescent soccer players) participated. Active LLLT (830 nm wavelength, 100 mW, spot size 0.0028 cm(2), 3-4 J per point) or an identical placebo LLLT was delivered to five points in the rectus femoris muscle (bilaterally). The main outcome measures were the work performed in the Wingate test: 30 s of maximum cycling with a load of 7.5% of body weight, and the measurement of blood lactate (BL) and creatine kinase (CK) levels before and after exercise. There was no significant difference in the work performed during the Wingate test ($P > 0.05$) between subjects given active LLLT and those given placebo LLLT. For volleyball athletes, the change in CK levels from before to after the exercise test was significantly lower ($P = 0.0133$) for those given active LLLT (2.52 U l(-1) +/- 7.04 U l(-1)) than for those given placebo LLLT (28.49 U l(-1) +/- 22.62 U l(-1)). For the soccer athletes, the change in blood lactate levels from before exercise to 15 min after exercise was significantly lower ($P < 0.01$) in the group subjected to active LLLT (8.55 mmol l(-1) +/- 2.14 mmol l(-1)) than in the group subjected to placebo LLLT (10.52 mmol l(-1) +/- 1.82 mmol l(-1)). LLLT irradiation before the Wingate test seemed to inhibit an expected post-exercise increase in CK level and to accelerate post-exercise lactate removal without affecting test performance. These findings suggest that LLLT may be of benefit in accelerating post-exercise recovery.

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The effect of low-level laser therapy on electrically induced muscle fatigue: a pilot study.

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OBJECTIVE: The purpose of this pilot study is to determine if low-level laser therapy (LLLT) could attenuate skeletal muscle fatigue induced by surface neuromuscular electrical stimulation (NMES) in healthy volunteers. MATERIALS AND METHODS: Five college-age participants underwent three cross-over randomized trials: two (LLLT + NMES) test trials and a control trial (NMES only), in which NMES was applied to their dominant knee extensor muscle group. The LLLT doses, 500 mW at 808 nm, were either adjusted to deliver a total energy of 7 J for 10 min or 3 J for 5 min in a blinded fashion. Following LLLT irradiation, the NMES protocol was immediately delivered for 3 min to induce fatigue in the knee extensor muscle group. RESULTS: The five participants completed the three trials. After the control trial, torque significantly decreased (62%; $p < 0.0001$) at the end of 3 min. There was no significant difference between the 7 J and 3 J trials on muscle fatigue. Following both LLLT trials, torque significantly decreased (51%; $p < 0.0001$) at the end of 3 min. Although there was a difference (11%) in fatigue between the two LLLT trials and the control trial, this difference did not attain statistical significance ($p = 0.63$). CONCLUSION: LLLT did not attenuate muscle fatigue evoked by NMES, but this needs to be further addressed in human studies and clinical settings. The lack of significant findings could be explained by the small sample size and the selection of LLLT parameters.

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Effect of 655-nm low-level laser therapy on exercise-induced skeletal muscle fatigue in humans.

Leal Junior EC, Lopes-Martins RA, Dalan F, Ferrari M, Sbabo FM, Generosi RA, Baroni BM, Penna SC, Iversen VV, Bjordal JM

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OBJECTIVE: To investigate if development of skeletal muscle fatigue during repeated voluntary biceps contractions could be attenuated by low-level laser therapy (LLLT). BACKGROUND DATA: Previous animal studies have indicated that LLLT can reduce oxidative stress and delay the onset of skeletal muscle fatigue. MATERIALS AND METHODS: Twelve male professional volleyball players were entered into a randomized double-blind placebo-controlled trial, for two sessions (on day 1 and day 8) at a 1-wk interval, with both groups performing as many voluntary biceps contractions as possible, with a load of 75% of the maximal voluntary contraction force (MVC). At the second session on day 8, the groups were either given LLLT (655 nm) of 5 J at an energy density of 500 J/cm2 administered at each of four points along the middle of the biceps muscle belly, or placebo LLLT in the same manner immediately before the exercise session. The number of muscle contractions with 75% of MVC was counted by a blinded observer and blood lactate concentration was measured. RESULTS: Compared to the first session (on day 1), the mean number of repetitions increased significantly by 8.5 repetitions (+/- 1.9) in the active LLLT group at the second session (on day 8), while in the placebo LLLT group the increase was only 2.7 repetitions (+/- 2.9) (p = 0.0001). At the second session, blood lactate levels increased from a pre-exercise mean of 2.4 mmol/L (+/- 0.5 mmol/L), to 3.6 mmol/L (+/- 0.5 mmol/L) in the placebo group, and to 3.8 mmol/L (+/- 0.4 mmol/L) in the active LLLT group after exercise, but this difference between groups was not statistically significant. CONCLUSION: We conclude that LLLT appears to delay the onset of muscle fatigue and exhaustion by a local mechanism in spite of increased blood lactate levels.

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Effect of 830 nm low-level laser therapy in exercise-induced skeletal muscle fatigue in humans.

Leal Junior EC, Lopes-Martins RA, Vanin AA, Baroni BM, Grosselli D, De Marchi T, Iversen VV, Bjordal JM

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This study aimed to investigate the effect of 830 nm low-level laser therapy (LLLT) on skeletal muscle fatigue. Ten healthy male professional volleyball players entered a crossover randomized double-blinded placebo-controlled trial. Active LLLT (830 nm wavelength, 100 mW output, spot size 0.0028 cm(2), 200 s total irradiation time) or an identical placebo LLLT was delivered to four points on the biceps humeri muscle immediately before exercises. All subjects performed voluntary biceps humeri contractions with a load of 75% of the maximum voluntary contraction (MVC) force until exhaustion. After active LLLT the mean number of repetitions was significantly higher than after placebo irradiation [mean difference 4.5, standard deviation (SD) +/- 6.0, P = 0.042], the blood lactate levels increased after exercises, but there was no significant difference between the treatments. We concluded that 830 nm LLLT can delay the onset of skeletal muscle fatigue in high-intensity exercises, in spite of increased blood lactate levels.

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Effects of Low-Level Laser Therapy and Eccentric Exercises in the Treatment of Recreational Athletes With Chronic Achilles Tendinopathy.

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BACKGROUND: Eccentric exercises (EEs) are recommended for the treatment of Achilles tendinopathy, but the clinical effect from EE has a slow onset. HYPOTHESIS: The addition of low-level laser therapy (LLLT) to EE may cause more rapid clinical improvement. STUDY DESIGN: Randomized controlled trial; Level of evidence, 1. METHODS: A total of 52 recreational athletes with chronic Achilles tendinopathy symptoms were randomized to groups receiving either EE + LLLT or EE + placebo LLLT over 8 weeks in a blinded manner. Low-level laser therapy (lambda = 820 nm) was administered in 12 sessions by irradiating 6 points along the Achilles tendon with a power density of 60 mW/cm(2) and a total dose of 5.4 J per session. RESULTS: The results of the intention-to-treat analysis for the primary outcome, pain intensity during physical activity on the 100-mm visual analog scale, were significantly lower in the LLLT group than in the placebo LLLT group, with 53.6 mm versus 71.5 mm (P = .0003) at 4 weeks, 37.3 mm versus 62.8 mm (P = .0002) at 8 weeks, and 33.0 mm versus 53.0 mm (P = .007) at 12 weeks after randomization. Secondary outcomes of morning stiffness, active dorsiflexion, palpation tenderness, and crepitation showed the same pattern in favor of the LLLT group. CONCLUSION: Low-level laser therapy, with the parameters used in this study, accelerates clinical recovery from chronic Achilles tendinopathy when added to an EE regimen. For the LLLT group, the results at 4 weeks were similar to the placebo LLLT group results after 12 weeks.

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Effect of phototherapy on delayed onset muscle soreness.

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OBJECTIVE: The purpose of this study was to investigate the effects of phototherapy on delayed onset muscle soreness (DOMS) as measured using the Visual Analog Scale (VAS), McGill Pain Questionnaire, Resting Angle (RANG), and girth measurements. BACKGROUND DATA: Previous research has failed to prove the beneficial effects of phototherapy on DOMS. METHODS: This was a randomized double-blind controlled study with 27 subjects (18-35 years) assigned to one of three groups. The experimental group received 8 J/cm2 of phototherapy each day for five consecutive days using super luminous diodes with wavelengths of 880 and visible diodes of 660 nm at three standardized sites over the musculotendinous junction of the bicep. The sham group received identical treatment from a dummy cluster. The controls did not receive treatment. The study was completed over five consecutive days: on day one baseline measurements of RANG and upper arm girths were recorded prior to DOMS induction. On days 2-5, RANG, girth, and pain were assessed using VAS and the McGill Pain Questionnaire. RESULTS: The experimental group exhibited a significant decrease in pain associated with DOMS compared to the control (p=0.01) and sham groups (p=0.03) based upon the VAS at the 48-h period. The McGill Pain Questionnaire showed a significant difference in pain scores at the 48-h period between the experimental and the sham groups (p=0.01). There were no significant differences day to day and between the groups with respect to girth and RANG. CONCLUSION: The results of this study provide scientific evidence that phototherapy as used in this study provides a beneficial effect to patients who may experience DOMS after a novel exercise session.

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Pain reduction by infrared light-emitting diode irradiation: a pilot study on experimentally induced delayed-onset muscle soreness in humans.

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The present pilot study investigated the analgesic efficacy of light-emitting diode (LED). In view of a standardised and controlled pain reduction study design, this in vivo trial was conducted on experimentally induced delayed-onset muscle soreness (DOMS). Thirty-two eligible human volunteers were randomly assigned to either an experimental (n=16) or placebo group (n=16). Immediately following the induction of muscle soreness, perceived pain was measured by means of a visual analog scale (VAS), followed by a more objective mechanical pain threshold (MPT) measurement and finally an eccentric/concentric isokinetic peak torque (IPT) assessment. The experimental group was treated with infrared LED at one of both arms, the other arm served as control. Irradiation lasted 6 min at a continuous power output of 160 mW, resulting in an energy density of 3.2 J/cm(2). The subjects of the placebo group received sham irradiation at both sides. In post-treatment, a second daily assessment of MPT and VAS took place. The treatment and assessment procedure (MPT, VAS and IPT) was performed during 4 consecutive days. Statistical analysis (a general linear model followed by post hoc least significant difference) revealed no apparent significant analgesic effects of LED at the above-described light parameters and treatment procedure for none of the three outcome measures. However, as the means of all VAS and MPT variables disclose a general analgesic effect of LED irradiation in favour of the experimental group, precaution should be taken in view of any clinical decision on LED. Future research should therefore focus on the investigation of the mechanisms of LED action and on the exploration of the analgesic effects of LED in a larger randomised clinical trial and eventually in more clinical settings.

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Lack of effect of combined low intensity laser therapy/phototherapy (CLILT) on delayed onset muscle soreness in humans.

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BACKGROUND AND OBJECTIVES: This study, which was approved by the University's Ethical committee, was conducted to investigate the effectiveness of Combined Low Intensity Laser Therapy/Phototherapy (CLILT) in alleviating the signs and symptoms of Delayed Onset Muscle Soreness (DOMS) over an 11-day period. STUDY DESIGN/MATERIALS AND METHODS: Thirty-six subjects (18 M: 18 F) were randomly allocated, under strictly controlled double-blind conditions, to one of three experimental conditions: Control, Placebo, and CLILT (660-950 nm; 11 J/cm2; pulsed at 73 Hz). DOMS was induced in a standardised fashion in the non-dominant elbow flexors using repeated eccentric contractions until exhaustion was reached. Subjects returned on five consecutive days, and two days during the following week, for treatment according to group, and assessment of outcome variables including range of motion, pain, and tenderness. RESULTS: While analysis of results using repeated measures and one factor ANOVA with post-hoc tests showed significant changes in all variables over time ($P < 0.05$) as a result of the induction procedure, there were no significant differences observed between groups. CONCLUSIONS: CLILT failed to show any beneficial treatment effect on DOMS, at least at the parameters used here. These results therefore provide no evidence for the claimed biostimulating effects of such therapy.

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Delayed-onset muscle soreness: lack of effect of combined phototherapy/low-intensity laser therapy at low pulse repetition rates.

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A double-blind, placebo-controlled study using male subjects (n = 60), was conducted to investigate the efficacy of three different frequencies of combined phototherapy/low-intensity laser therapy (CLILT) in alleviating the signs and symptoms of delayed-onset muscle soreness (DOMS). The study was approved by the University's ethical committee. After screening for relevant pathologies, recent analgesic or steroid drug usage, current pain, diabetes, or current involvement in regular weight-training activities, subjects were randomly allocated to one of five experimental groups: Control, Placebo, or 2.5-Hz, 5-Hz, or 20-Hz CLILT groups (660-950 nm; 31.7 J/cm2; pulsed at the given frequencies for a duration of 12 min; n = 12 all groups). Once baseline measurements were obtained, DOMS was induced in the nondominant arm, which was exercised in a standardized fashion until exhaustion, using repeated eccentric contractions of the elbow flexors. The procedure was repeated twice more to ensure exhaustion was achieved, after which subjects were treated according to group allocation. In the CLILT/placebo groups, the treatment head was applied directly to the affected arm at the level of the musculotendinous junction. Subjects returned on two consecutive days for further treatment and assessment. The range of variables used to assess DOMS included range of movement (universal goniometer), mechanical pain threshold/tenderness (algometer) and pain (visual analogue scale and McGill Pain Questionnaire). Measurements were taken before and after treatment on each day, except for the McGill Pain questionnaire, which was completed at the end of the study. Analysis of results using repeated measures and one-factor analysis of variance with relevant post hoc tests showed significant changes in ranges of movement accompanied by increases in subjective pain and tenderness for all groups over time (p = 0.0001); however, such analysis failed to show any significant differences between groups on any of the days. These results thus provide no convincing evidence for any putative hypoalgesic effect of CLILT upon DOMS at the parameters used here.

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